APPENDIX F
A CGE MODEL FOR ANALYZING ENERGY AND ENVIRONMENT POLICIES

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In recent years concern with greenhouse gas emissions has focussed attention on the crucial link between economic growth, energy utilization and global climate change. We propose a conceptual framework and outline a model for analyzing macroeconomic effects of energy and environment policies.

BACKGROUND

An inadequate and uncertain supply of energy can impose a binding constraint on the capacity of the materials production sector in developing countries. It consequently restricts their growth potential severely. An inefficient pattern of energy utilization exacerbates the problem of inadequate supply. Demand for energy is likely to grow many fold in the near future. Massive investments in the energy sector are planned to boost energy supply in many countries. This will, on the one hand, tie up significant amount of economic resources and on the other, be a source of serious environment problems. Therefore, attention is simultaneously focussed on appropriate price and taxation policies to regulate the consumption of total energy as well as of specific fuels.

Energy efficiency programs have an important role in reducing the seriousness of these problems. A dilemma which policy makers face is : where should the additional dollar be invested? In increasing the capacity of the energy sector or for improving energy efficiency?

The macroeconomic effects of such investment choices can be analyzed in the framework of a multi-sector computable general equilibrium (CGE) model. Existing models of energy-economy interaction have failed to address the above dilemma in an integrated way. The analysis of macroeconomic consequences of investment in improving energy efficiency has, by and large, been neglected. Also, the question of emission of greenhouse gases associated with the increased use of energy has been approached with a limited perspective, whereby once the limited possibilities of interfuel substitution are exhausted, emissions are reduced by lower energy consumption linked to reduced economic activity. The positive effect of investment in improving energy efficiency has often been given limited attention.

MODEL STRATEGY AND DESCRIPTION

The model analyses the behavior of households, firms and government in the perspective of their interaction with the rest of the world. The general equilibrium nature of the model indicates that the effects of a policy change are not limited to the particular sector where they are initiated, but propagate themselves throughout the economy by interactive feedback mechanisms. Focussing

on the energy sector, the model is addressed specifically to the following issues of current policy concern:

- What is the effect of increased investment in the energy sector on economic growth? How does economic growth in turn affect demand for energy?
- What is the effect of increased domestic prices of energy on domestic demand for energy and the effect of these on sectoral production and on GDP?
- As opposed to the above, what is the effect of increased investment in improving energy efficiency?

The model can also be used to address the following questions:

- What is the effect of CO2 emission restrictions on macroeconomic aggregates like GDP and employment? Are these effects sensitive to the choice of alternative policy instruments for emissions restrictions?
- How do these restrictions translate themselves in terms of costs and prices of energy and other goods and what implications these have for demand and supply in different sectors?

In this model the effects of policies are analyzed on different points of time in a comparative static framework. The link between these points is provided by saving and investment decisions which determine the capital stock and hence the productive capacity for each sector at the beginning of each period.

The energy-economy interaction is modeled by dividing the economy in terms of Materials sector and Energy sector. The materials sector is subdivided into agriculture, basic industry, other industry, construction, transport and services. The energy sector is subdivided into crude extraction, natural gas, electricity and petroleum products.

A distinctive feature of this model is that energy inputs into the productive process, as well as energy consumption by the household sector, are assumed to be sensitive with respect to investment in energy efficiency programs. This is in contrast to the practice in conventional models where energy use is assumed to be a fixed proportion of output or is assumed to be sensitive to respect to energy prices only. The model allows for interfuel substitution both in the production sector and the household sector.

The model is set in the overall macroeconomic consistency framework of a Social Accounting Matrix (SAM). This matrix is obtained by combining the National Accounts Statistics, the Input/Output Tables, and the Energy Balance of an economy. The model is parameterised using the data from a SAM for a base year.

While the model is quite general in its specification, it is at present being used to analyze energy-economy interactions in Venezuela. For this purpose the base year of the model is 1990. For exogenously specified growth rates and levels of capital stock and labor supply, the model will analyze the direction and magnitude of chosen macroeconomic variables for the Venezuelan economy for a time horizon of twenty years up to the year 2015.

In the near future, the model will also be used to analyze energy and environment policy for Nigeria.